Significant range extensions for *Delma labialis* and a review of its biology

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ABSTRACT

We report southern, western and northern extensions of known range for the vulnerable legless lizard, *Delma labialis*: respectively, north of Moranbah from a sandstone ridge near a river; east of Charters Towers from grassy open woodland; and Cape York Peninsula from sandy heath. These extensions increase the species' extent of occurrence by more than 66,000 km^2, a nearly nine-fold increase in area. We suggest that *D. labialis* is widespread within its extent, but that it is patchily distributed and at low population densities. We review current knowledge of the species, with particular reference to known habitats, and make comments on its conservation status and potential threats.

Key words: Pygopodidae, Gekkota, legless lizard, Queensland endemic.

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Introduction

The Stripe-tailed Delma *Delma labialis* Shea 1987 is a poorly known flap-footed (pygopodid) lizard. It is listed as *vulnerable* under Queensland legislation, but was recently downgraded from *vulnerable* to unlisted under federal legislation. Little has been published on this species since the original description (Shea 1987), except a short note by Lloyd (2005), inclusion in survey reports (e.g., Augusteyn 2007) and field guides (e.g., Couper *et al.* 2000; Wilson 2005; Wilson and Swan 2010) and a profile by Vanderduys (2012) in a publication on Queensland's threatened animals. We report significant range extensions, involving habitats not normally associated with the species, and review current knowledge of the lizard, including previously unpublished information.

Extensions of known range

SOUTHERN. At 19:16 on 19 October 2010, a road-killed *D. labialis* was collected by SLM approximately 42 km north of Moranbah in central Queensland on a road adjacent to Burton Gorge Dam (-21.624°, 148.119°). Tissue was taken and the specimen was lodged in the Queensland Museum (QM J89155). The record is approximately 120km from the coast and represents a significant southern and inland extension of the lizard's known range (see Distribution section below). The closest previous record is from Conway State Forest (Augusteyn 2007), approximately 150 km to the northeast (Fig. 1).

WESTERN. On the evening of 23 February 2012, a live *D. labialis* was found by CJH on Burdekin Falls Dam Road about halfway between Mingela and Ravenswood, east of Charters Towers (approximate coordinates: -20.009°, 146.786°; Fig. 1). The animal was found crossing the road in an area of grassy open woodland. The animal was photographed (Fig. 2) and then released to the side of the road. Nearby records include one 70km north at Mt Stuart (A. McNab, pers. comm.) and one 100km east at Mt Abbot (QM J62740). While records from the Paluma region (e.g., Lloyd 2005) are further west, they are only approximately 20km from the coast. At approximately 75km from the coast, this new record represents a significant western/inland extension for this latitude.

NORTHERN. On 1 August 2009, a live *D. labialis* was trapped in a funnel trap by RB in Heathlands Resources Reserve (-11.733°, 142.605°). The specimen was vouchered and registered with the Queensland Museum (QM J89591). At 10:00 AM on 29 October 2012, a live *D. labialis* was collected (QM J92580; Fig. 3) by SLM on the Southern Bypass Road in Heathlands Resource Reserve, Cape York Peninsula (-11.67554°, 142.646°). These two records are approximately 900km north of the nearest previous records (Paluma; QM J57304 and Lloyd (2005)). At the time of collection, SLM was unaware of the previous Heathlands record. Tissue was taken from both specimens.

All four specimens clearly keyed to *D. labialis* using the keys in Shea (1987) and Wilson (2005), and matched the description in Wilson and Swan (2010), viz: 3 preanal scales, 4th upper labial below eye, dark dorsolateral stripes present, face and side of neck barred (Figs. 2 and 3).

The habitats for the new records are discussed in detail below.

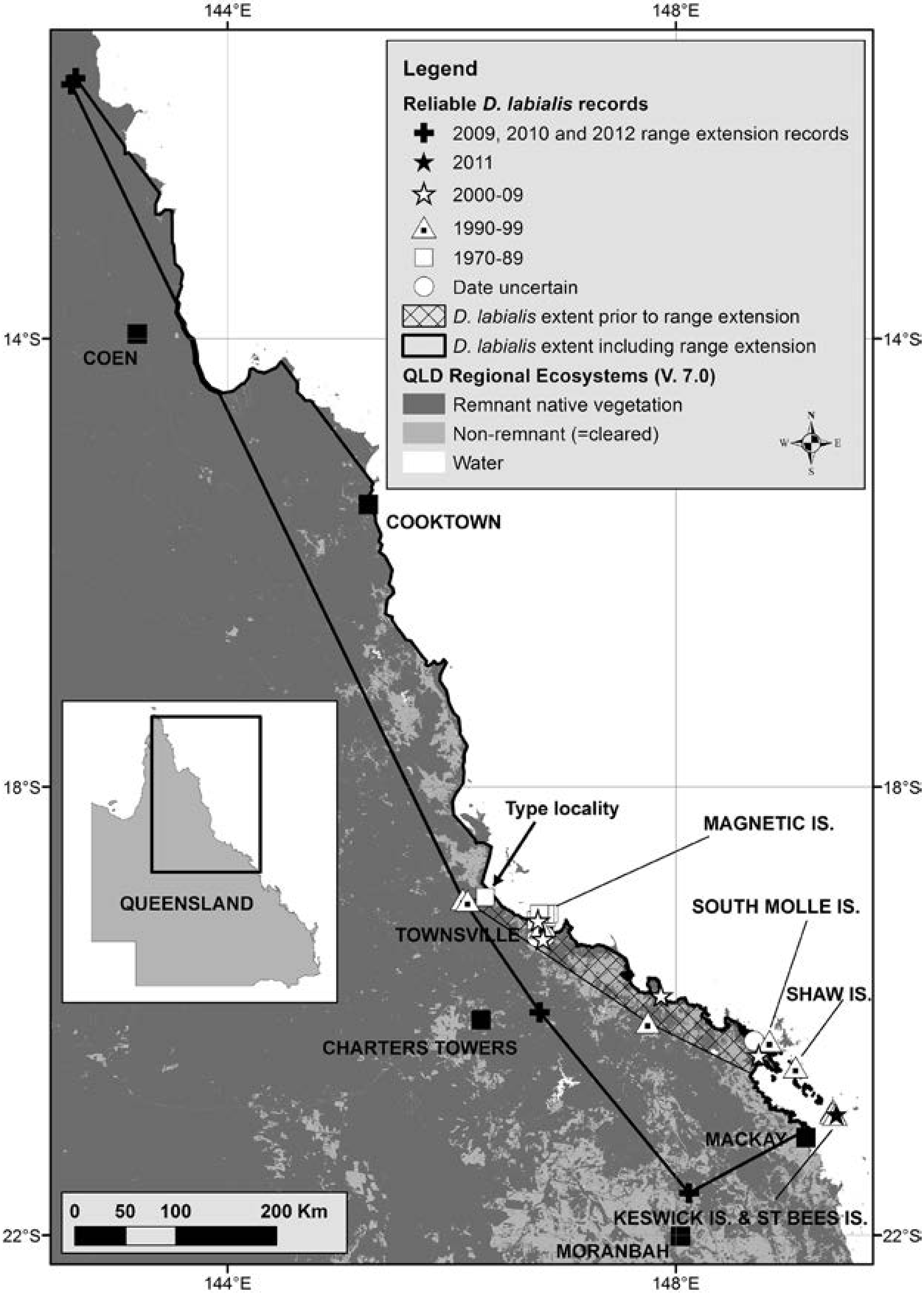
144°E
148°E
14°S
18°S
22°S
Legend
Reliable D. labialis records
2009, 2010 and 2012 range extension records
2011
2000-09
1990-99
1970-89
Date uncertain
D. labialis extent prior to range extension
D. labialis extent including range extension
QLD Regional Ecosystems (V. 7.0)
Remnant native vegetation
Non-remnant (=cleared)
Water
N
S
E
W
COEN
COOKTOWN
Type locality
MAGNETIC IS.
SOUTH MOLLE IS.
SHAW IS.
TOWNSVILLE
CHARTERS TOWERS
MACKAY
KESWICK IS. & ST BEES IS.
MORANBAH
QUEENSLAND
0 50 100 200 Km

Figure 1. Map showing all available *Delma labialis* records, including recent range extensions. The current and previous extents of occurrence are outlined.

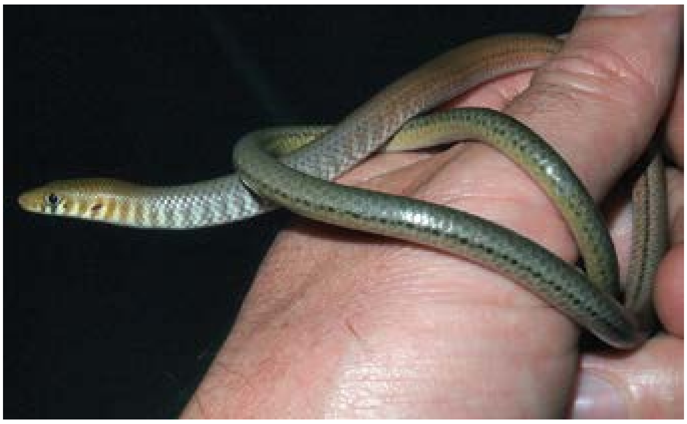

Figure 2. *Delma labialis* found in the Ravenswood area, east of Charters Towers. Photo, Megan Higgie.

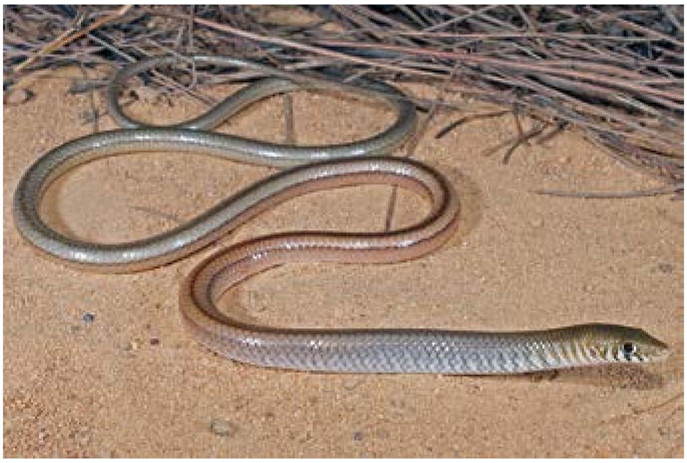

Figure 3. *Delma labialis* (QM J92580) in life from Heathlands Resources Reserve. Photo, Stewart Macdonald.

Review notes

Nomenclature

The generally accepted common name for *D. labialis* is Stripe-tailed Delma, but it is also known as the Single-striped Delma (Cogger *et al.* 1993; Queensland Museum 2009; DERM 2010a; DSEWPC 2011a; Vanderduys 2012). Given that the species usually has a pair of stripes, we recommend against using the latter as a common name.

Description

Delma labialis is a large flap-footed lizard with a reported snout–vent length (SVL) to 126mm and a tail to 490mm, but it is usually smaller than this (Vanderduys 2012). The SVLs of the holotype and paratype were 103.5mm and 115mm, respectively (Shea 1987). It has no forelimbs, and the hindlimbs are reduced to scaly flaps (Shea 1987). Dorsally it is dull tan to silvery brown, the tail usually copper in colour darkening to reddish-brown distally (Vanderduys 2012). The head is usually yellow-tinted with obscure to distinct pale bands on the lips, neck and throat that fade caudally over the first third of the body (Shea 1987; Vanderduys 2012). There is a narrow, dark, dorsolateral stripe on each side of the posterior body that extends onto the tail, where it often fades distally (Vanderduys 2012). Sometimes these stripes start as a series of dark spots on the anterior third of the body and coalesce into stripes caudally. Regenerated tails may lack these stripes. The two Heathlands specimens are unique in having a prominent dark vertebral stripe commencing approximately halfway along the body and extending down the length of the tail, fading distally (Fig. 3).

Genetics

Intraspecific genetic variation has not been assessed. Such a study is made difficult by the lack of genetic material currently available and the difficulty of finding live specimens from which to obtain new material. *Delma labialis* is closely allied to *Aclys concinna* based on phylogenetic analysis by Jennings *et al.* (2003), which included a comparison of mitochondrial and nuclear DNA. However, rather than moving *D. labialis* to *Aclys*, they proposed that *A. concinna* be assigned to *Delma*, a move that has since been widely accepted (e.g., Wilson and Swan 2010). That these two species are each other's closest relatives is of note, as they occur on opposite sides of the continent. They are believed to have diverged between 22 and 30 MYA (Jennings *et al.* 2003). The Jennings *et al.* study did not include all *Delma* species, and so a more comprehensive study might recover different relationships.

Distribution

Prior to the range extensions detailed above, the distribution of *D. labialis* was thought to extend from around Paluma, south to Keswick Island off Mackay; the species was also known from Magnetic Island, South Molle Island and Shaw Island (Fig. 1; Wilson and Swan 2010). There were also four 2011 records from St Bees Island, which is about 600m east of Keswick Island (DERM 2012a). With the records reported here, the species is now known to occur substantially further inland, south and north than previously thought (Fig. 1). The extent of occurrence in 2009 (including the area of the islands from which it was known) was mapped and calculated at 8,909 km^2 using ESRI ArcMap 10. The new extent of occurrence, which includes the range extension records, is calculated at 75,860 km^2. Extent of occurrence is based on a minimum convex polygon linking known records, with sea excluded from the polygon.

The area of occupancy of *D. labialis* (i.e., the actual area occupied by populations of the species) within its current extent of occurrence is unknown, and therefore it is not known whether there are disjunctions in its mainland distribution. Given the large expanse of habitat between the Heathlands and Paluma records, an area that contains heavily populated towns (Townsville and Cairns) and that has received considerable survey effort, it seems likely that the Heathlands population is isolated from the other population/s. This is, of course, difficult to determine without substantial additional survey effort. Accurate distributional information is lacking as the species is seldom recorded, with only 18 specimens in the Queensland Museum and an additional 18 records in the Queensland Department of Environment and Resource Management WildNet database (Queensland Museum 2009; DERM 2012a). It is likely that this lack of records is due to a combination of the species being cryptic, occurring in low densities and being patchily distributed across the landscape.

Habitat

Delma labialis occurs in the dry tropics, with wet summers and dry winters (BOM 2009). It has been recorded from >750 m ASL in Paluma Range National Park north of Townsville (Lloyd 2005), down to low coastal elevations (as determined by GIS mapping of Queensland Museum and Queensland WildNet records). The new records presented here were from 150–300m ASL.

Delma labialis has been recorded from open forests, open woodlands, coastal vine forest and thickets, a wet sclerophyll–rainforest ecotone, a seasonally dry swamp and heathlands. Figure 4A shows typical habitat. Ground layer and mid-storey vegetation seems to be important, with thick *Xanthorrhoea*, *Acacia* and/or grass cover usually present (Cogger *et al.* 1993; Wilson 2005; Augusteyn 2007; Woodcock 2008; Queensland Museum 2009; DERM 2012a). The Federal Government considers "Forests to open-woodlands and adjacent exposed rocky slopes to 800 metres above sea level in QLD RE Land Zones 2, 3 and 12" to be suitable habitat for the species (DSEWPC 2011b).

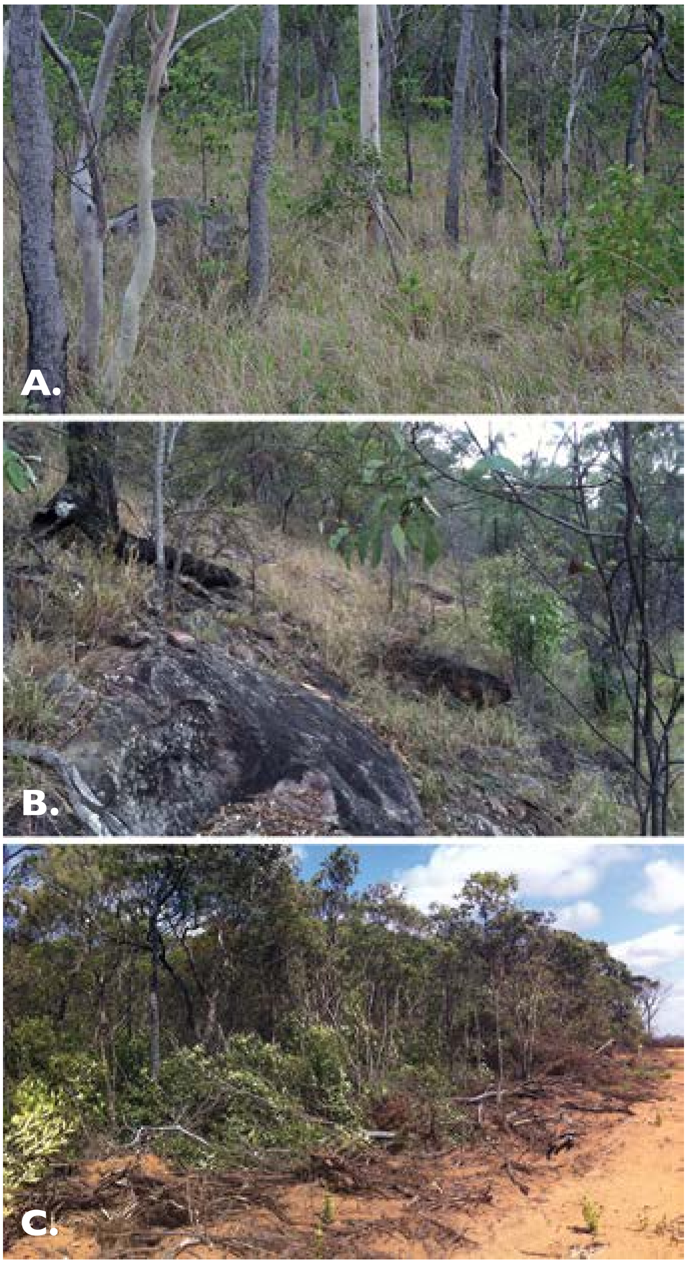

Figure 4. *Delma labialis* habitat. **A**: Mixed forest on coastal plain, with ground layer of Megathyrsus maximus, Heteropogon contortus, Sorghum sp., *Themeda triandra* **and** *Imperata cylindrica. Near Cockle Bay,* Magnetic Island. Photo, Eric Vanderduys; **B**: Sandstone rise next to the road on which QM J89155 was found. North of Moranbah; **C**: Heath beside the sand-plain road on which QM J92580 was found. Heathlands Resources Reserve.

All available records with sufficient spatial accuracy were compared to regional ecosystem (RE) maps and descriptions (DERM 2012b and c) and are summarised in Table 1. It should be noted that RE assignment is based largely on floristics and geology. Various other factors, such as microhabitat and shelter availability, contribute to a habitat's suitability for any particular species. Detailed habitat descriptions for the new locations reported here follow. The Moranbah specimen was found on a road with a thick, grassy verge either side dominated by introduced buffel grass (*Cenchrus ciliaris*). Directly adjacent to one verge was partially cleared forest on the banks of the Isaac River, with *Corymbia tessellaris, Corymbia clarksoniana* and buffel grass present. On the other side of the road was a rocky sandstone rise with *Eucalyptus crebra, C. tessellaris*, native grasses and acacias (Fig. 4B). The REs within 400m of the site were 11.10.4a (grassy eucalypt woodland) and 11.3.25 (eucalypt open forest to woodland, ground cover of grasses, sedges and forbs), with 11.10.3 (shrubby acacia low open forest to open forest, sparse ground cover of grasses and forbs) likely. It is also possible that a small, unmapped patch of 11.3.4 (grassy eucalypt woodland to open forest) was present.

The Ravenswood specimen was found on a road surrounded by RE 9.12.1. This RE is ironbark-dominated, low open woodland to woodland with a grassy ground cover. The mixed RE polygon 9.3.1/9.3.12a also occured along watercourses in the area. RE 9.3.1 is a *E. camaldulensis* and/or *E. tereticornis* dominated grassy woodland to open forest fringing water channels, and RE 9.3.12a is riverine wetland.

The 2012 Heathlands specimen was found on an unpaved, sand plain roadway, with roadside vegetation mapped as RE 3.5.19 (*Asteromyrtus lysicephala*, *Choriceras tricorne* open heath on sand sheets; Fig. 4C). The upper canopy was sparse, with occasional *Grevillea glauca* and *Neofabricia myrtifolia*, with *Grevillea pteridifolia* forming an equally sparse mid-storey. The understorey was dominated by dense post-fire regrowth of *Dodonaea polyandra*. Other species present included *Acacia flavescens*, *A. simsii*, *Pandanus spiralis* and *Xanthorrhoea johnsonii*. Grasses were virtually absent in the understorey, but a sparse cover of the sedge *Schoenus sparteus* was present. The community structure and floristic composition was typical of a heathland-type community several years post-fire, although there was evidence of recent fire in one small roadside vegetation patch. The 2009 Heathlands specimen was found in a similar heath community, but that also contained *Asteromyrtus brassii*, *Jacksonia thesioides*, *Melaleuca nervosa*, *Allocasuarina littoralis*, *Banksia dentata*, *Leptospermum* sp. and *Eucalyptus* sp. The site was burnt in 2006, and by 2009 several plant species in the post-fire regeneration were flowering and seeding.

Table 1: Regional Ecosystem (RE) codes and descriptions associated with *Delma labialis* records.

Specimen/ Location	RE code/description	Notes/Sources
Moranbah	11.10.4a/11.3.25 grassy eucalypt woodland 11.10.3 shrubby acacia low open forest on scarps and crests.	Specimen was found on sealed road with woodland on one side and a sandstone scarp on the other. See text for full details.
Ravenswood	9.12.1 ironbark-dominated, low open woodland to woodland with a grassy ground cover	See text for details.
Heathlands	3.5.19 *Asteromyrtus lysicephala, Choriceras tricorne* open heath on sand sheets	See text for details.
Shaw Island	Likely to be 8.3.2 *Melaleuca viridiflora* woodland to open-forest, on seasonally inundated alluvial plains with impeded drainage.	Dry swamp - seasonal (Queensland Museum 2009).
Castle Hill, Townsville	Likely to be 11.12.16 mixed low woodland to shrubland on igneous rocks	Spinifex (*Triodia stenostachya*) (DERM 2012a).
Magnetic Island	11.2.3 evergreen to semi-deciduous notophyll to microphyll coastal scrub	Record is based on a pers. comm. mentioned in Shea's (1987) description of the species, in which he states the record is from wet sclerophyll forest. After inspecting RE mapping of the region and discussion with the original observers (G. Husband and A. Dudley, pers. comm. Oct 2013), we consider vine thicket to be a more appropriate habitat description.
Cape Upstart	11.2.3 evergreen to semi-deciduous notophyll to microphyll coastal scrub	Woodcock 2008.
Conway State Forest	8.12.5c *Eucalyptus portuensis* dominated open forest with a ground cover often dominated by a mix of grasses, *Xanthorrhoea, Macrozamia* and *Dianella*	Augusteyn 2007.
St Bees Island 1	8.12.25/8.12.12d *Eucalyptus/ Corymbia* woodland to open-forest on hill slopes	Featuring an *Allocasuarina* and *Ficus* shrub layer, a dense layer of grasses and sedges, and fallen timber with some rocks; unburned for about 20 years (A. Dinwoodie and J. Augustyn, unpublished data).
St Bees Island 2	8.12.13a grassland or shrubland on slopes	*Lantana*-dominated shrubland, with a dense grass layer (*Aristida personata* and *Heteropogon contortus*) and some rocks; unburned for about 20 years (A. Dinwoodie and J. Augustyn, unpublished data).

Microhabitats in which *D. labialis* has been found include grasstree (*Xanthorrhoea* sp.) litter, in woodland litter, in spinifex clumps, in a dry creek bed in grassy woodland, and under timber, rocks and sheets of iron (Low 1978; Queensland Museum 2009; DERM 2012a; A. McNab pers. comm. 2011; Limpus and Lyon 2012; Vanderduys 2012). There are records from vegetation on rocky hillsides and on quaternary coastal sands (Woodcock 2008; Queensland Museum 2009; DERM 2012a; DERM 2012b; DERM 2012c; Limpus and Lyon 2012). Vanderduys (2012) reports that it appears to prefer areas with thick ground cover. Associated species can include spinifex (*Triodia* spp.), spear grass (*Heteropogon contortus*), kangaroo grass (*Themeda triandra*), razor grasses (*Scleria* spp.) and saw sedges (*Gahnia* spp.) (Vanderduys 2012). It may also use introduced grasses like Guinea grass (*Megathyrsus maximus* var. *maximus*) where these are adjacent to large tracts of native vegetation with thick ground cover (Vanderduys 2012).

Reproduction

The individual from Moranbah (QM J89155) was a gravid female (SVL 123mm), with one egg protruding from a tear in the body wall. Apart from this, there are no other data on reproduction, growth and maturation in this species. Clutch size in *Delma* spp. is usually two eggs (Patchell and Shine 1986; Pianka 2010).

Behaviour

This species is reported to be diurnal (Shea 1987; Wilson 2005; Wilson and Swan 2010; Vanderduys 2012), particularly from midday to late afternoon (Vanderduys 2012). However, it has also been found crossing roads at dusk (R. Lloyd pers. comm. 2010), and Vanderduys (2012) reports individuals being active as late as 9 PM. It is also reported to be extremely wary and usually glimpsed only fleetingly (Wilson 2005). In cooler months it has been found under rocks, logs and human rubbish (Vanderduys 2012). The Moranbah specimen was collected from a road at 7:16 PM. Its relatively fresh appearance suggested it had been killed within the previous couple of hours (i.e., it had been active on the road at or around dusk). The Ravenswood specimen was observed at approximately 8–9 PM on a warm evening. When approached, this individual thrashed around wildly on the road. The 2012 Heathlands specimen was found on a road at 10 AM on a hot, dry, sunny day. When approached, it made a concerted and energetic effort to escape to the side of the road but was thwarted by the loose sand of an embankment.

The federal *Survey guidelines for Australia's threatened reptiles* suggest that pit-trapping may be an effective method of surveying for *D. labialis* (DSEWPC 2011c), and buckets successfully captured the four individuals from St Bees Island. The 2009 Heathlands specimen was caught in a funnel trap, so we would recommend that a comprehensive survey also include these, along with active searching such as log/tin-flipping and searching along roadways at dusk. Given that these three range extension records all occurred in habitat not typically associated with *D. labialis*, it is possible that the species occurs in an even wider range of habitat types than listed here. As such, *D. labialis* should be considered as potentially occurring throughout much of north-eastern Queensland.

Diet

No specific information on diet is available, but most *Delma* species eat insects and spiders (Patchell and Shine 1986; Pianka 2010). The 2012 Heathlands specimen was maintained in captivity for a few days during transportation, and readily fed upon crickets.

Conservation status

Delma labialis is currently listed as *vulnerable* under the Queensland *Nature Conservation Act 1992* and the IUCN Red List. The species was formerly listed as *vulnerable* under the Federal *Environment Protection and Biodiversity Conservation Act 1999*, but was delisted 15 May 2013, largely due to insufficient data for most criteria. While the Threatened Species Scientific Committee did consider the range of the species to be limited, it also felt the species had a "broad distribution that is not precarious for its survival" (TSSC 2013).

Threats

Up until 2009, around 26% of native vegetation within *D. labialis*' extent of occurrence had been cleared (Fig. 1), but it is unknown if this has had a significant effect on the species because its area of occupancy is unknown. There has been significant clearing along the coastal half of its extent. Three main areas of clearing to the southeast of Townsville are used for agriculture, mainly sugar cane, but there is also horticultural use of cleared land near Bowen (BDTNRM 2009; WHAM 2006). These areas devoted to agriculture have no records of *D. labialis*, but it is not known if the lizard occurred in these agricultural areas prior to clearing. Nonetheless, Vanderduys (2012) was still concerned about the impact of clearing for agriculture on the lizard.

In recent times the threat from broad scale clearing in Queensland eased somewhat, as clearing of remnant and high-value regrowth vegetation ceased in 2006 and 2009, respectively (DERM 2009), but the ban on the clearing of regrowth vegetation is likely to be reviewed in the near future. However, illegal clearing should not be discounted as a future threat until the rate of such clearing is determined in areas where this lizard occurs. Impact on the lizard from clearing for purposes such as residential development, infrastructure construction and mining, which are exempt from the *Vegetation Management Act 1999* (DERM 2009), is currently unknown.

The rapid and extensive clearing of woodland habitat for residential and associated development in some areas (e.g., the Townsville region) is an incremental threat to this species. Vanderduys (2012) and K. McDonald (pers. comm. 2009, DERM) have raised concerns about the impact on *D. labialis* of habitat loss and fragmentation from ongoing urbanisation and rural residential development in the coastal strip from Mackay to Ingham. McDonald has particular concerns for areas to the north and south of Townsville, at Airlie Beach and in the Proserpine area. Ongoing human development and population growth in regions in which the lizard occurs also means additional habitat fragmentation and road usage, which is likely to negatively affect the lizard.

Apart from a population of *D. labialis* on Castle Hill in Townsville, which appears to be isolated as a result of urban development disrupting all potential natural vegetation corridors (Vanderduys 2012), there are currently insufficient data to show to what extent clearing has led to geographically separated populations. Small populations isolated due to clearing would be particularly prone to extinction from threats such as predation (including from domestic and feral animals), drought and inappropriate fire regimes. The population of *D. labialis* on Castle Hill could be under threat from fire and would also be vulnerable to predation by domestic cats from surrounding urban areas (Vanderduys 2012).

Mining activities in the Moranbah region are likely to impact on *D. labialis* through habitat destruction and fragmentation. Impacts from factors such as fire, grazing, predation, illegal collecting are impossible to quantify because of the difficulty of obtaining relevant data.

Although climate change has the potential to impact on *D. labialis*, there is no direct evidence to suggest it is currently affecting populations. Given the cryptic nature of this species, long-term monitoring measures would be difficult to implement. Broad climate change predictions and trends in the Queensland Brigalow Belt and Central Queensland Coast bioregions where the lizard occurs are summarized by Low (2011), and include: a decrease in rainfall, especially in spring; more intense weather systems; and increasing annual average temperatures with a resultant increase in evapotranspiration. Reduced rainfall, changes to rainfall patterns and increasing temperatures will see a reduction in average soil moisture, which has the potential to change vegetation composition and structure in ways that could be detrimental to *D. labialis*. Krockenberger *et al.* (2004) have identified vine thickets in the dry tropics, a known habitat for *D. labialis*, as particularly susceptible to climate change by changes in rainfall patterns and fire regimes. Fire regimes could alter in intensity, seasonality and/or frequency.

If climate change modeling is correct, then there will also be a trend to more frequent droughts (DERM 2010). Severe drought could: impact on vine thicket and wet sclerophyll forest extent; impact on vegetation composition and cover at ground level; and increase the incidence of fire and the associated adverse impacts, such as reducing the extent of grasslands and thick ground cover, both of which appear to be important for this species. The range extensions detailed herein show that *D. labialis* occurs in a wide variety of habitats across a wide distribution. These two factors should afford this species at least some protection from changing climates.

Protective measures

The *Draft Queensland Brigalow Belt Reptile Recovery Plan* (Richardson 2008) includes *D. labialis*, but does not have management practice recommendations specifically tailored for the species. Most Queensland Museum register (2009) and DERM WildNet (2012a) records of the lizard are from the Queensland protected estate, where a number of known and possible threats are absent or reduced. It has been recorded from six national parks (Cape Upstart, Lindeman Islands, Magnetic Island, Molle Islands, Paluma Range and South Cumberland Islands), the Townsville Town Common and Cape Pallarenda Conservation Parks, Conway State Forest and Heathlands Resources Reserve (Augusteyn 2007; DERM 2012a).

The Queensland biodiversity offset policy, which came into effect in July 2008 (DERM 2012d), may provide the opportunity to protect habitat for the lizard on any land that is set aside to mitigate environmental impacts of development activities such as mining and gas extraction. Under this policy, offset lands have legal environmental protection either through gazettal into the protected estate, declaration as an area of high nature conservation value under the Queensland *Vegetation Management Act 1999* or by a protective covenant under the Queensland *Land Act 1994* or *Land Title Act 1994* (DERM 2012d).

Based on current *D. labialis* records, all open forests, woodlands, coastal vine forests, wet sclerophyll–rainforest ecotones and heathlands within the lizard's extent are vegetation types that, if cleared, would require offsets under Queensland legislation. Specifically, this would include Queensland REs: 3.5.19, 8.3.2, 8.12.5c, 8.12.25, 8.12.12d, 9.3.1, 9.3.12a, 9.12.1, 11.2.3, 11.3.4, 11.10.3, 11.10.4a and 11.12.16.

There is some concern for the long-term viability of the isolated population on Castle Hill, Townsville, where household cats from surrounding urban areas and non-optimal fire regimes are possible threats (E. Vanderduys pers, comm. 2009, CSIRO). Urban cats need to be prevented from roaming. Fires that regularly burn all spinifex and adjoining vegetation cover at this site are unlikely to be suitable for the long-term persistence of the lizard. The impact of fire on the lizard needs to be investigated, not just here, but elsewhere within its extent of occurrence.

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